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Anticoagulation and Antiplatelet Regimen in Cardiac Transplant. Clinical Characteristics, Outcomes, and Blood Product Transfusion

Maria del Val Groba Marco[1,2] | Pedro Saavedra Santana[3] | Luz Maria Gonzalez del Castillo[4] | Mario Galvan Ruiz[1] | Miguel de Fernandez de Sanmamed[1] | Stefano Urso[5] | Elisabet Guerra Hernández[6] | Laura Quintana Paris[4] | Michelle Tout Castellano[7,8] | Jose Luis Romero Lujan[8] | Eduardo Jose Caballero Dorta[1,2] | Luisa Maria Guerra Dominguez[4] | Antonio Garcia Quintana[1]

[1]Cardiology Department, Hospital Universitario de Gran Canaria Dr. Negrin, Las Palmas de Gran Canaria, Spain | [2]Departamento de Ciencias Medicas y Quirurgicas, Universidad de Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain | [3]Departamento de Matemáticas, Universidad de Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain | [4]Hematology Department, Hospital Universitario de Gran Canaria Dr. Negrin, Las Palmas de Gran Canaria, Spain | [5]Department of Cardiac Surgery, Hospital Universitario de Gran Canaria Dr. Negrin, Las Palmas de Gran Canaria, Spain | [6]Department of Anesthesiology, Hospital Universitario de Gran Canaria Dr. Negrin, Las Palmas de Gran Canaria, Spain | [7]Transplant Coordination Unit, Hospital Universitario de Gran Canaria Dr. Negrin, Las Palmas de Gran Canaria, Spain | [8]Department of Critical Care, Hospital Universitario de Gran Canaria Dr. Negrin, Las Palmas de Gran Canaria, Spain

Correspondence: Maria del Val Groba Marco (maria.groba101@alu.ulpgc.es)

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ABSTRACT

Background: We aimed to evaluate the characteristics, clinical outcomes, and blood product transfusion (BPT) rates of patients undergoing cardiac transplant (CT) while receiving uninterrupted anticoagulation and antiplatelet therapy.

Methods: A retrospective, single-center, and observational study of adult patients who underwent CT was performed. Patients were classified into four groups: (1) patients without anticoagulation or antiplatelet therapy (control), (2) patients on antiplatelet therapy (AP), (3) patients on vitamin K antagonists (AVKs), and (4) patients on dabigatran (dabigatran). The primary endpoints were reoperation due to bleeding and perioperative BPT rates (packed red blood cells (PRBC), fresh frozen plasma, platelets). Secondary outcomes assessed included morbidity and mortality-related events.

Results: Of the 55 patients included, 6 (11%) received no therapy (control), 8 (15%) received antiplatelet therapy, 15 (27%) were on AVKs, and 26 (47%) were on dabigatran. There were no significant differences in the need for reoperation or other secondary morbidity-associated events. During surgery patients on dabigatran showed lower transfusion rates of PRBC (control 100%, AP 100%, AVKs 73%, dabigatran 50%, $p = 0.011$) and platelets (control 100%, AP 100%, AVKs 100%, dabigatran 69%, $p = 0.019$). The total intraoperative number of BPT was also the lowest in the dabigatran group (control 5.5 units, AP 5 units, AVKs 6 units, dabigatran 3 units; $p = 0.038$); receiving significantly less PRBC (control 2.5 units, AP 3 units, AVKs 2 units, dabigatran 0.5 units; $p = 0.011$). A Poisson multivariate analysis showed that only treatment on dabigatran reduces PRBC requirements during surgery, with an expected reduction of 64.5% (95% CI: 32.4%–81.4%).

Conclusions: In patients listed for CT requiring anticoagulation due to nonvalvular atrial fibrillation, the use of dabigatran and its reversal with idarucizumab significantly reduces intraoperative BPT demand.

1 | Introduction

Nowadays, cardiac transplant (CT) recipients tend to be older, ~~and~~ have more comorbidities, and they often need anticoagulation or antiplatelet therapy [1]. In parallel, the therapeutic arsenal has expanded with the introduction of direct-acting oral anticoagulants (DOAC), including FXa inhibitors, such as rivaroxaban, apixaban, and edoxaban, and the direct thrombin inhibitor (dabigatran), as well as newly developed antiplatelet drugs like ticagrelor and prasugrel.

The use of these treatments has demonstrated a positive clinical benefit-risk profile in clinical trials and real-world data. However, they may increase the risk of perioperative hemorrhagic complications [2, 3], thromboembolic events, or necessitate surgery delay to discontinue treatment preventively. For patients on the CT waitlist, immediate and precise reversal of these treatments is paramount to mitigate hemorrhagic complications. Additionally, there is a limited experience in the management of these drugs in CT patients, and we lack updated scientific evidence in perioperative CT care.

On the other hand, there is also a limited amount of evidence on blood product transfusion (BPT) in CT [4]. BPT is a costly and limited resource that is associated with multiple risks [5], and there is a necessity to discern which patients will benefit from reserved BPT and reduce transfusion requirements.

This study was aimed to evaluate the characteristics, clinical outcomes, and BPT rates of patients undergoing CT while receiving uninterrupted anticoagulation and antiplatelet therapy. It also seeks to identify the risk factors associated with perioperative transfusions and describe the trend in anticoagulation therapy use among patients on the CT waitlist.

2 | Methods

This retrospective, observational study included all adult patients (age >16 years) who underwent CT at the Hospital Universitario de Gran Canaria Doctor Negrin, Spain, from November 2019 to July 2023. All CT were de novo, orthotopic procedures, performed using the bicaval technique. Data were collected from medical records, the blood bank database, and the Spanish Heart Transplant Registry [6].

Patients receiving heparin or pretransplant circulatory support, as well as those on a different DOAC besides dabigatran, were excluded from the study.

The remaining cohort was categorized into four groups based on their pretransplant regime: (1) patients without anticoagulation or antiplatelet therapy (control), (2) patients receiving antiplatelet therapy with acetylsalicylic acid (ASA), clopidogrel or ticagrelor (AP), (3) patients receiving vitamin K antagonists (AVKs), and (4) patients receiving anticoagulation with dabigatran (dabigatran).

Patients who discontinued anticoagulation for more than 3 days or antiplatelet therapy for more than 7 days before surgery were considered as having no preoperative therapy (control).

All patients in the dabigatran group received idarucizumab (Praxbind, Boehringer Ingelheim) in two boluses (2.5 g × 2/50 mL) 2 h prior to CT. Patients on AVKs were administered oral vitamin K (Konakion), and fresh frozen plasma (FFP) or prothrombin complex concentrate.

Recipient epidemiological and baseline variables included age, sex, etiology of heart disease, relevant comorbidities, laboratory parameters such as hemoglobin levels, platelets count, renal, and liver function. Post-CT variables analyzed included the need for reoperation in the immediate perioperative period due to bleeding, BPT including FFP, platelets and packed red blood cells (PRBC), hemoglobin levels and platelets counts before and after CT, duration of total hospital and intensive care unit (ICU) stay, and 30-days survival rate. Activated partial thromboplastin time (APTT) levels before and after idarucizumab administration were recorded in patients on dabigatran.

The primary endpoints were reoperation in the immediate perioperative period to control bleeding and BPT rates intraoperatively, 24- and 48-h postsurgery. Secondary outcomes assessed: morbidity-related events and clinical outcomes such as extracorporeal circulation time, length of ICU and total hospital stay, postoperative atrial fibrillation, thromboembolic events, need for renal replacement therapy, and 30-day survival.

Blood utilization was analyzed using the following indices and equations [7]:

- Transfusion probability (T%): the percentage of patients that required BPT calculated by dividing the number of patients with any transfusion by the total number of patients in the group.
- Transfusion index (Ti): the ratio of the number of the PRBC units transfused to the number of patients receiving PRBC transfusions.
- Total transfusion index (TTi): the ratio of the total number of BPT units to the number of patients receiving any BPT.

A statistical analysis was conducted, with categorical variables expressed as frequencies and percentages, and continuous variables presented as mean and standard deviation (SD) if data followed a normal distribution, or as median and interquartile range (IQR = 25th–75th percentile) if the distribution deviated from normality. Percentages were compared using the Chi-square (χ^2) test or the exact Fisher test as appropriate. Means were compared using the *t*-test, and medians were compared using the Wilcoxon test for independent data.

Poisson models were used to identify the factors associated with the number of PRBC during surgery [8]. These models made it possible to obtain ratios of mean PBRC, allowing for comparison of mean PBRC consumption between groups. Initially, a univariate Poisson analysis was conducted for each factor separately to test the association of the factor with the mean number of PRBC. Subsequently, the factors that showed an association with the number of PBRC were included in a multivariate Poisson analysis. Variable selection was then carried out based on the best subset of variables and the Bayesian

Information Criterion. From the model obtained, the significant mean ratios of PRBC were estimated.

Statistical significance was set at $p < 0.05$. Data were analyzed using the R package, version 4.2.1 (R Development Core Team, 2022) [9].

The study was approved by the Clinical Research Ethics Committee of the Hospital Universitario de Gran Canaria Dr. Negrín (Las Palmas, Spain) and was conducted in compliance with the Declaration of Helsinki.

3 | Results

During the study period, 70 de novo CT were performed. Thirteen patients on pretransplant circulatory support and heparin treatment, as well as two patients on preoperative apixaban, were excluded.

A total of 55 patients were included in the study. Of these patients, 6 (11%) received no therapy (control), 8 (15%) antiplatelet therapy (AP), 15 (27%) were on AVKs, and 26 (47%) were on dabigatran. Within the AP group, one patient received dual antiplatelet therapy with ASA and ticagrelor, while the others received only ASA. Patients' epidemiological and baseline characteristics, surgery, and donation data are presented in Table 1. Significant differences were observed in recipient demographic data, including previous sternotomy (control 33%, AP 0, AVKs 27%, dabigatran 4%; $p = 0.032$), underlying etiology (ischemic cardiomyopathy: control 17%, AP 88%, AVKs 7%, dabigatran 35%; $p < 0.001$), coagulation results prior to CT (normal: 67% control, 75% AP, 13% AVKs, and 15% dabigatran; $p < 0.001$), and patients location (home: 67% control, 88% AP, 93% AVKs, and 62% dabigatran; $p = 0.045$).

Before surgery no significant differences were observed in renal or hepatic function, platelet count, or hemoglobin levels. The median International normalized ratio (INR) in the AVK group was 2.05 (IQR = 1.45–2.7) prior to surgery and 1.3 (IQR = 1.08–1.49) postsurgery. In the dabigatran group, the median APTT before idarucizumab administration was 42.4, (IQR = 37.9–48.6). After the reversal agent, the mean APTT value was 30.1 (IQR = 28.1–33.1), with a median percentage reduction in APTT of 26.3% (IQR = 19.5%–34.6%). No patients received an additional dose of idarucizumab during surgery.

There were no significant differences in the need for reoperation due to bleeding (one patient in the control and one patient in the dabigatran group; $p = 0.378$), hemoglobin levels after surgery (Control 10.4 g/dL, AP 10.1 g/dL, AVKs 10.5 g/dL, Dabigatran 10.1 g/dL; $p = 0.653$), postoperative atrial fibrillation rates (control 17%, AP 25%, AVKs 20%, Dabigatran 8%; $p = 0.421$), or acute renal failure (Control 50%, AP 50%, AVKs 53%, Dabigatran 54%; $p = 1$). Rejection rates were also similar among the four groups. There were no differences in ICU (Control 8 days, AP 11 days, AVKs 5 days, 7 days; $p = 0.225$) or total hospital stay (Control 20 days, AP 38 days, AVKs 21 days, 20 days; $p = 0.872$).

Table 2 displays the T% and number of BPT in each group. The intraoperative T% of PRBCs, FFP, and platelets in the total cohort was 69%, 64%, and 87%, respectively. The T% was significantly lower in the dabigatran group for PRBC (control 100%, AP 100%, AVKs 73%, dabigatran 50%, $p = 0.011$) and platelets (control 100%, AP 100%, AVKs 100%, dabigatran 69%, $p = 0.019$).

During surgery, in the dabigatran group, the total number of BPT was significantly lower (control 5.5 units, AP 5 units, AVKs 6 units, dabigatran 3 units; $p = 0.038$), as well as of PRBC (control 2.5 units, AP 3 units, AVKs 2 units, dabigatran 0.5 units; $p = 0.011$). No significant differences were observed in T% of blood products 24 or 48 h after surgery, or in the overall perioperative period.

The TI of PRC and TTI during surgery, 24 h after surgery, and in the overall perioperative period were also lower in the dabigatran group (Figure 1). The AP group had the highest TI and TTI during surgery, and in the overall perioperative period.

In the univariate Poisson analysis, the variables that showed a significant association with the number of PRBC during surgery were treatment ($p = 0.002$), ischemic cardiomyopathy ($p = 0.024$), extracorporeal circulation time ($p < 0.001$), and ischemia time ($p = 0.001$).

Multivariate Poisson regression showed that the factors that maintained an independent association with PRBC were treatment and extracorporeal circulation time. The use of dabigatran with idarucizumab was the only treatment shown to be a protective factor, with a significant reduction in the mean number of PRBC of 64.5% (95% CI: 32.4–81.4; $p < 0.001$) relative to control treatment. Extracorporeal circulation time proved to be a risk factor, significantly increasing intraoperative PRBC demand. Each minute of extracorporeal circulation time increased the predicted number of PRBC by 1.6% (95% CI: 0.9%–2.3%; $p < 0.001$).

No thromboembolic events occurred during the waitlist period. However, during the perioperative period, 70-year-old women with nonischemic familiar cardiomyopathy and nonvalvular atrial fibrillation (NVAF) on AVKs before surgery, anticoagulated with prophylactic low molecular weight heparin after CT, experienced an ischemic mesenteric thromboembolic event at day eighteen of CT.

The overall 30-day survival was comparable between groups (control 100%, AP 100%, AVKs 87%, dabigatran 100%; $p = 0.193$).

4 | Discussion

Our study provides valuable evidence on the management of anticoagulation and antiplatelet therapy in CT, as well as BPT use in this setting.

We observe a high prevalence of patients on anticoagulation or antiplatelet therapy (91% of patients; $N = 64$), high overall intraoperative T%, Ti, and TTi (Figure 1), and no thromboembolic events during the waitlist period. These findings underscore the need for a careful evaluation and management of these treatments, emphasizing the importance of tailoring presurgical treatment, transfusion strategies, and hemostatic protocols in CT recipients.

TABLE 1 | Epidemiological and baseline characteristics of patients and surgery data.

	Control ($N = 6$)	AP ($N = 8$)	AVKs ($N = 15$)	Dabigatran ($N = 26$)	*p*-value
Recipients					
Age (years)	56.8 ± 4.1	57.9 ± 8.4	58 ± 12.7	55 ± 8.2	0.74
Sex male	5 (83.3)	6 (75)	13 (86.7)	19 (73.1)	0.801
BMI (kg/m^2)	25.2 ± 4.9	24.1 ± 4.7	23.7 ± 5	25.6 ± 4.2	0.579
Previous sternotomy	2 (33.3)	0	4 (26.7)	1 (3.9)	0.032
Underlying etiology					<0.001
Non-ischemic dilated	2 (33.3)	1 (12.5)	8 (53.3)	17 (65.4)	
Ischemic	1 (16.7)	7 (87.5)	1 (6.7)	9 (34.6)	
Other	3 (50)	0	6 (40)	0	
Coagulation results					<0.001
Normal	4 (66.7)	6 (75)	2 (13.3)	4 (15.4)	
Intrinsic pathway	0	2 (25)	0	9 (34.6)	
Extrinsic pathway	2 (33.3)	0	9 (60)	1 (3.8)	
Both pathways	0	0	4 (26.7)	12 (46.2)	
Pulmonary vascular resistance (UW)	1.6 (1.3; 1.8)	2.4 (2.2; 2.7)	1.5 (1.3; 2.2)	1.9 (1.1; 2.4)	0.199
Insulin-dependent diabetes	2 (33.3)	2 (25)	3 (20)	6 (23.1)	0.929
Peripheral arterial disease	0	2 (25)	2 (13.3)	4 (15.4)	0.725
Anemia previous surgery	4 (66.7)	3 (37.5)	4 (26.7)	7 (26.9)	0.329
Hemoglobin (g/dL)	12.3 ± 1.3	13.2 ± 1.3	14.3 ± 2.1	13.6 ± 2.1	0.182
Platelets (×10^3)	232.8 ± 93.7	204.2 ± 61.6	203.5 ± 78.1	214.5 ± 82.5	0.878
Creatinine (mg/dL)	1.3 (1; 1.8)	1.3 (1.1; 1.4)	1.4 (1.2; 1.7)	1.3 (1.1; 1.6)	0.848
Chronic kidney disease	4 (66.7)	5 (62.5)	10 (66.7)	19 (73.1)	0.919
Bilirubin (>2 mg/dL)	1 (16.7)	0	2 (13.3)	2 (7.7)	0.554
Time on waitlist	62 (14; 81)	20 (2; 35)	137 (31; 152)	36 (14; 88)	0.088
Patients' localization					0.045
Home	4 (66.7)	7 (87.5)	14 (93.3)	16 (61.5)	
Hospital floor	1 (16.7)	1 (12.5)	1 (6.7)	10 (38.5)	
Critical care unit	1 (16.7)	0	0	0	
Donation after circulatory death	0	2 (25)	0	6 (23.1)	0.115
Ischemia time (min)	155 (132; 179)	138 (102; 174)	152 (132; 184)	132 (118; 166)	0.576
Extracorporeal circulation time (min)	100 (88; 103)	95 (89; 116)	107 (100; 113)	103 (88; 118)	0.693

Note: Data are means ± SD, frequencies (%) and medians (IQR).

When we include a patient on transplant waitlist, it is crucial to assess their preoperative therapy, evaluate thromboembolic risk factors, and plan the perioperative and post-transplant phases accordingly. The aim is to minimize the risk of thromboembolic events while avoiding excessive bleeding complications, especially when an unexpected compatible donor becomes available.

Moreover, perioperative hemorrhage treatment and transfusion protocols in CT lack a comprehensive approach, and these patients are underrepresented in trials investigating bleeding and transfusions during cardiac surgery [10–12]. Therefore, in CT, adherence to current cardiac surgery guidelines for perioperative hemostasis and transfusion management is strongly recommended [13–14].

In recent years, DOACs have emerged as the preferred therapeutic option over warfarin in patients with NVAF [15]. However, there is limited data on their use in CT. Idarucizumab was approved by the FDA in 2015 as a reversal agent for dabigatran [16]. This is a humanized monoclonal antibody fragment that binds dabigatran with high affinity and specificity, and rapidly reverses its anticoagulant activity, enabling the chronic use of dabigatran in patients with NVAF awaiting CT and its reversal before surgery, when a compatible donor becomes available. In the literature,

TABLE 2 | Outcomes and clinical events of interest after cardiac transplant.

	Control ($N = 6$)	AP ($N = 8$)	AVKs ($N = 15$)	Dabigatran ($N = 26$)	*p*-value
Morbidity					
Reoperation to control bleeding	1 (16.7)	0	0	1 (3.9)	0.378
Hemoglobin after surgery (g/dL)	10.4 (9.9; 11.2)	10.1 (9.2; 10.8)	10.5 (10.1; 10.8)	10.1 (9.6; 11)	0.653
Platelet count after surgery	164 (120; 192)	148 (108; 180)	146 (110; 166)	141 (128; 168)	0.921
Primary graft disfunction (%)	1 (16.7)	0	0	2 (7.7)	0.304
Post-operative atrial fibrillation	1 (16.7)	2 (25)	3 (20)	2 (7.7)	0.421
Acute renal failure	3 (50)	4 (50)	8 (53.3)	14 (53.9)	1
Renal replacement therapy in critical care unit	1 (16.7)	3 (37.5)	5 (33.3)	7 (26.9)	0.842
Intensive care unit stay, days	8 (6.2; 10.5)	11 (5.8; 14)	5 (5; 7.5)	6.5 (5; 7.8)	0.225
Total hospital stay, days	19.5 (15.8; 36.8)	38 (16.5; 51)	20.5 (17.2; 22)	20 (18; 23)	0.872
Total number endomiocardial biopsies	7.5 (6.2; 9.5)	6 (5.5; 6.2)	7 (6; 7)	5 (4.2; 6.8)	0.08
First endomiocardial biopsy >1R, *N* (%)	0	2 (25)	2 (15.4)	4 (15.4)	0.727
Second endomiocardial biopsy >1R, *N* (%)	1 (16.7)	1 (12.5)	1 (7.7)	2 (7.7)	0.906
Total number endomiocardial biopsy >1R	1 (0; 2.8)	0 (0; 1)	0 (0; 1)	0 (0; 1)	0.477
Transfusion of blood products					
T% in surgery, *N* (%)					
PRBC	6 (100)	8 (100)	11 (73.3)	13 (50)	0.011
FFP	3 (50)	4 (50)	12 (80)	16 (61.5)	0.381
Platelets	6 (100)	8 (100)	15 (100)	18 (69.2)	0.019
Total number blood products transfused in surgery	5.5 (5; 6)	5 (4.5; 9)	6 (4; 8)	3 (2; 5)	0.038
Total PRBC	2.5 (2; 3)	3 (1.8; 4.2)	2 (0.5; 2)	0.5 (0; 2)	0.011
Total FFP	1 (0; 2)	1 (0; 2.2)	3 (2; 4)	2 (0; 3)	0.078
Total platelets (pools)	2 (1.2; 2)	2 (1.8; 2.5)	1 (1; 2)	1 (0; 2)	0.17
T% 24 h after surgery, *N* (%)					
PRBC	2 (33.3)	4 (50)	8 (53.3)	11 (42.3)	0.839
FFP	1 (16.7)	1 (12.5)	3 (20)	3 (11.5)	0.938
Platelets	2 (33.3)	2 (25)	2 (13.3)	2 (7.7)	0.225
T% 48 h after surgery, *N* (%)					
PRBC	1 (16.7)	0	3 (20)	3 (11.5)	0.651
FFP	0	0	0	0	1
Platelets	0	0	2 (13.3)	1 (3.9)	0.695
Total blood products transfusion during surgery and 48 h after	6.5 (6; 7.8)	5 (3.8; 9)	6 (5; 8.5)	4.5 (2; 6.8)	0.115
Mortality					
30-d survival	6 (100)	8 (100)	13 (86.7)	26 (100)	0.193

Note: Data are means ± SD, frequencies (%) and medians (IQR).
Abbreviations: PRC, packed red blood cells; T%, transfusion probability.

there are only a few reported isolated cases and two larger series of only 10 and 53 patients [17, 18], showing promising results on dabigatran in CT patients.

In our series, we observe a growing trend toward the use of dabigatran in patients on CT waitlist, at the expense of AVKs (Figure 2). We attribute this shift to several factors, including ease of management before surgery, fewer drug interactions, favorable safety profile, and documented efficacy [19]. Additionally, the availability of idarucizumab as a specific reversal agent has contributed to the increased acceptance and confidence in using dabigatran in CT.

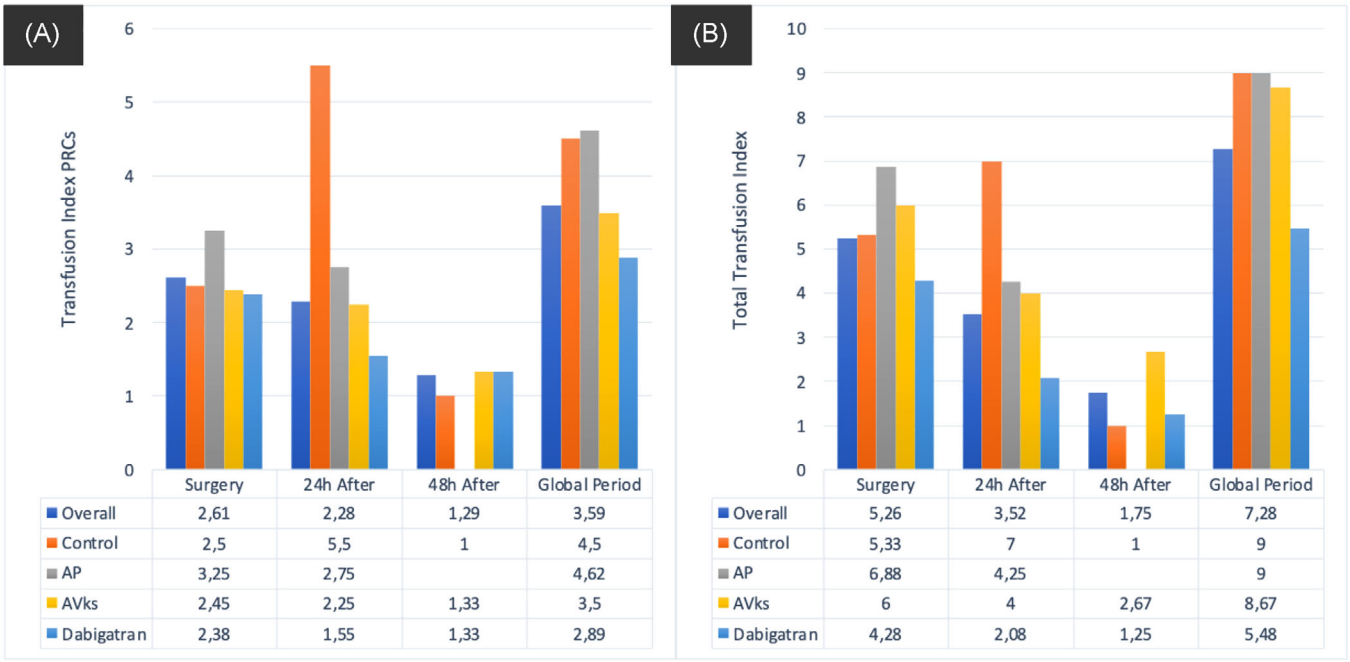

FIGURE 1 | Packed red blood cells (PRBC) and total transfusion indices of the overall cohort, patients without anticoagulation or antiplatelet therapy (control), patients on antiplatelet therapy (AP), patients on vitamin K antagonists (AVKs), and patients on dabigatran (dabigatran) during surgery, 24 h after, 48 h after, and in the overall perioperative period including surgery, 24- and 48-hour after CT).

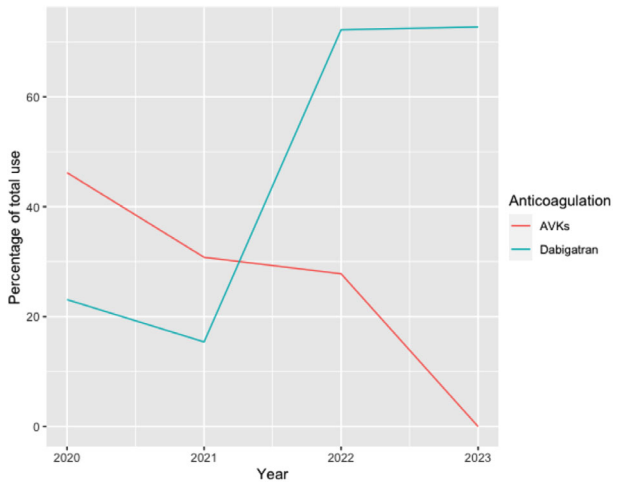

FIGURE 2 | Trend of anticoagulation use in patients undergoing cardiac transplant from January 2020 to July 2023.

Patients receiving dabigatran had 5 g of intravenous idarucizumab administered 2 h prior to CT, without an additional dose. It is worth noting that it may be considered to administer a second dose of 5 g of idarucizumab if coagulation parameters remain prolonged and clinical need persists. Like in the findings from the Reverse AD study [20], APPT was used to evaluate the anticoagulant effect of dabigatran. This approach demonstrated the high efficacy of idarucizumab in normalizing the prolonged coagulation parameters, thereby reversing the anticoagulant effect of dabigatran.

There were no significant differences within the four groups regarding the need for reoperation due to bleeding or procedure-associated morbidity events. However, it is important to interpretate these results cautiously, as the total number of events per group was low. Nonetheless, we observed a significant reduction in intraoperative BPT in patients on waitlist receiving dabigatran and the reversal protocol with idarucizumab prior to surgery.

Cardiac surgery is frequently associated with perioperative bleeding and high BPT rates, which are costly, limited and entail significant risks [5, 21]. Despite publication of transfusion practice guidelines [14], there is considerable variation in hospital transfusion rates [22]. In the context of CT, there is limited evidence regarding transfusion rates [4, 5, 23], particularly concerning patients on anticoagulation or antiplatelet regimens during CT waitlist. In the absence of specific data, a restrictive erythrocyte transfusion strategy (hemoglobin threshold between 7.5 and 8 g/dL) is recommended for CT, potentially tailored to tissue perfusion or oxygenation values [13, 24].

In our study, during surgery, the overall T% and number of BPT were high, with 69% of patients requiring PRBCs with a median of 2 units (IQR 0;3), 64% requiring PFC with a median of 2 units (IQR 1;2), and 86% requiring platelets with a median of 2 units (IQR 1;2). The highest PRBCs rates during surgery were observed in the AP group (T% of 100%, with a median of 3 units) and the significantly lowest rates in the dabigatran group (T% of 50%, with 0.5 median units). Previous reports have indicated an average of three PRBCs transfused in CT [4] and in a Spanish multicenter study on the use of idarucizumab in CT, 66% of the cohort received BPT [18].

Interestingly, after adjusting for confounders using Poisson regression, two variables were independently associated with intraoperative PRBC transfusion rates.

Firstly, dabigatran was associated with a significant reduction in the mean number of PRBCs of 64.5% (95% CI: 32.4–81.4; $p < 0.001$).

Secondly, extracorporeal circulation time was identified as a risk factor, with each minute of extracorporeal circulation time associated with a 1.6% increase in the expected number of PRBC transfused. Although literature reports in cardiac surgery suggest that platelet counts decrease and postoperative bleeding risk increases with prolonged extracorporeal circulation time [25, 26], there is limited evidence specifically pertaining to CT.

Cardiac guidelines recommend the continuation of ASA therapy when indicated. However, the uninterrupted P2Y12 inhibitors are associated with increased postoperative bleeding, thus being unsuitable for CT candidates. In our study we noted significant BPT rates in the AP group, although only one patient received dual antiplatelet therapy with ASA and ticagrelor. Patients on antiplatelet therapy experienced more bleeding and had the highest BPT exposure during surgery and in the perioperative period. Hence, careful consideration of antiplatelet therapy indications is warranted. In cases requiring dual antiplatelet therapy, thienopyridines (clopidogrel, prasugrel) is preferred over ticagrelor due to the inefficacy of platelet transfusion in neutralizing ticagrelor's effects within 24 h before surgery. In cases of severe perioperative bleeding, reversal of antiplatelet agents using platelet concentrates may be considered, guided by platelet function testing [13].

Patients with a history of sternotomy are known to have an increased risk of post-CT morbidity and mortality, including a higher risk of reoperation and transfusions in the immediate perioperative period [27]. While there were no significant variations in platelet or hemoglobin counts, a higher proportion of patients had a previous sternotomy in the control and AVK groups. This could have influenced the intraoperative transfusion rates in these groups and may explain the higher BPT demands in the control group.

Notably, preoperative anemia was highly prevalent in our cohort, affecting 32.7% of the patients, with no significant differences between groups. Addressing anemia before surgery with a multidisciplinary management involving hematology department, could have improved surgical and BPT outcomes.

Understanding the risk factors for PRBC transfusion requirements in CT facilitates the anticipation and mobilization of preventive resources, such as reassessment of perioperative antiplatelet and anticoagulation regimens, administration of antidotes, and treatment of preoperative anemia. Moreover, identifying patients who require PRBC reserves optimizes the use of these limited and costly hospital resources.

Currently, in CT, dabigatran in combination with a reversal protocol using idarucizumab is preferred over anti-Xa DOACs [13]. However, the emergence of novel antidotes, such as andexanet alfa (Andexxa), which rapidly reverses the anticoagulant effect of oral FXa inhibitors, may expand treatment options in CT [28]. Other promising reversal agents include ciraparantag, which has preferential binding to heparins and DOACs [29].

Our study has limitations inherent to its observational and retrospective design, including a small sample size that may have limited statistical power to demonstrate clinically relevant results. Variability in anticoagulation reversal management and transfusion practices among healthcare professionals may also affect outcomes. Additionally, the lack of data on perioperative blood loss rates and anticoagulation levels in patients treated with dabigatran, limits the comprehensive assessment of bleeding risk in this population. Blood levels of dabigatran, diluted thrombin time, and anti-Xa activity were not assessed because they are not available at our institution, and we acknowledge the limited accuracy of APTT in assessing anticoagulation levels in patients treated with dabigatran.

5 | Conclusions

In conclusion, in patients undergoing CT requiring anticoagulation due to NVAF, the use of dabigatran on the waitlist and its reversal with idarucizumab prior to surgery yields favorable clinical outcomes and significantly reduces intraoperative BPT demand. Nonetheless, further studies are warranted to validate these findings and assess their broader applicability.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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